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Bleeding Risk Assessment and Choice of Antiplatelet Treatment in Acute Coronary Syndrome Patients

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ABSTRACT

Background: Patients with coronary artery disease are usually treated with dual antiplatelet therapy after percutaneous coronary intervention and are at risk of both ischaemic and bleeding events. Prevention of bleeding is as important as prevention of ischemia. **Objective:** To determine the frequency of bleeding risk assessment and choice of antiplatelet treatment in acute coronary syndrome patients, at a tertiary care hospital, Karachi. **Material and Methods:** This cross-sectional study was conducted with 135 ACS patients of both gender with age 30-75 years. Bleeding risk assessment was conducted using CRUSADE scoring system with five categories i.e, very low (≤20), low (21–30), moderate (31–40), high (41–50), and very high (>50). The choice of antiplatelet therapy was evaluated accordingly. Statistical analysis was conducted using SPSS. Chi-square tests was applied to determine statistical significance, with a threshold of P ≤0.05. **Results:** The study had a male predominance (56.3%). NSTEMI was the most prevalent ACS subtypeand was significantly associated with higher bleeding risk (p=0.012), classified as very high risk. Hypertension and diabetes mellituswere strongly linked to increased bleeding risk (p<0.001 and p=0.001). Dual antiplatelet therapy was the preferred strategy, with aspirin+clopidogrel (40.7%) and aspirin+ticagrelor (34.1%) being the most frequently prescribed combinations (p<0.001). **Conclusion:** This study highlights significant variability in bleeding risk among ACS patients, with NSTEMI showing highest risk profile. Hypertension, diabetes mellitus, and family history of ACS were strongly associated with elevated bleeding risk, emphasizing need for individualized antiplatelet therapy selection.

INTRODUCTION

Patients who have acute coronary syndrome (ACS) are at a lower risk of developing thrombotic complications, such as myocardial infarction and mortality, when they are protected by powerful platelet inhibition medicines. Synergistic effects and more effective thrombosis prevention can be achieved by targeting several pathways involved in thrombotic processes. This is true both in the short-term and the long-term aftermath of an acute coronary syndrome (ACS). It is impossible to deny the fact that more powerful platelet inhibition raises the danger of bleeding.[1] As many as one in five people who have experienced acute coronary syndrome will experience a second ischemia episode during the next five years at some point.[2-4]

There are a number of characteristics that are associated with residual risk, and these factors can be reduced by the use of pharmacologic and nonpharmacologic therapies.[2] A crucial component in the treatment of acute coronary syndrome is the use of antiplatelet medication.[3,5] Acetylsalicylic acid (ASA), which is a cyclooxygenase-1 inhibitor, was first established as an effective treatment for myocardial infarction approximately half a century ago. Additionally, it continues to be the antiplatelet medication that is used the most often.[6,7]

One potentially deadly complication of percutaneous coronary interventions (PCI)—the so-called "stent protective effect"—is stent thrombosis, which occurs in the first weeks after DAPT and is a consequence of inflammation and endothelial damage caused by mechanical insult.[8-10] As more time passes, the purpose of DAPT changes and evolves. Long-term treatment has been found to reduce the incidence of recurrent ischemia events, whether they are related with the culprit lesions or arteries or arise from the development of atherosclerosis. This phenomenon, which is sometimes referred to as the "patient protective effect," is a significant therapeutic benefit.[11,12]

Despite the fact that ASA is successful in lowering death rates,[13] the combination of ASA with a second antiplatelet medication, a P2Y12 receptor inhibitor (also known as dual antiplatelet treatment [DAPT]), offers additional

benefits and is currently the recommended first approach for acute coronary syndromes in comparison to ASA alone.[14] Using dual antiplatelet treatment (DAPT) to inhibit platelet activity after acute coronary syndrome (ACS) is done with the intention of reducing the onset of both short-term and long-term thrombotic problems.[8]

Over the course of time, a number of antithrombotic medications have been presented with the intention of offering the maximum possible thrombotic protection while simultaneously counterbalancing the accompanying hemorrhagic hazards. In accordance with European guidelines,[15-17] the use of the two most modern and powerful P2Y12 inhibitors, namely prasugrel and ticagrelor, in conjunction with aspirin, with or without PCI, is now suggested for all patients who are appropriate for Atrial Fibrillation (ACS).[18,19]

Aspirin with a P2Y12 inhibitor for a period of twelve months is the dual antiplatelet treatment (DAPT) that is advised during percutaneous coronary intervention (PCI), followed by long-term aspirin monotherapy.[20,21] However, while making clinical decisions about the ideal length of DAPT after PCI, it is important to take into consideration a number of parameters, including the bleeding risk profile and the initial clinical presentation itself.[22] For patients who have been on DAPT for a period of one year, the incidence of severe bleeding caused by TIMI may vary anywhere from one to four percent.[23-25]

In the first year after the beginning of DAPT, there is an increase in significant bleedings that occurs in around 1–8% of patients. This is the price that must be paid for a higher decrease in the risk of thrombotic events.[18,19,26-29] DAPT withdrawal, unanticipated hospitalization, and the necessity for urgent operations are all examples of indirect processes that might potentially raise fatality rates, even in cases when the bleeding is not very severe.[30] Bleeding is thus indirectly connected to the recurrence of ischemic events like myocardial infarction (MI) and stroke and directly linked to higher mortality.[31,32] In spite of the fact that it has been ignored for a considerable amount of time, studies conducted in real life have shown that the incidence of bleeding outside of hospitals, as well as the morbidity and mortality that are linked with it, are both rather high. In light of this, it may be concluded that the avoidance of bleeding after intervention is just as essential as the prevention of atherosclerosis.[33]

Although there are little international and very limited local studies available on this critical issue, there is also lack of rigorously carried out analytical data and reviews in this region. The main objective of this research is to estimate the frequency of Bleeding Risk assessment and choice of antiplatelet treatment in acute coronary syndrome patients. This reliable and updated data would be help for assessing the gravity of the situation, providing evidence for patients, clinicians and policy makers along with interventional educational programs.

MATERIAL AND METHODS

The study follows a descriptive cross-sectional design and conducted among the inpatients of the Department of Cardiology at Liaquat National Hospital & Medical College, Karachi. Thestudy spans six months from July 2024 to December 2024, following approval by the College of Physicians and Surgeons Pakistan (CPSP). Following ethical approval, patient enrollment proceeds with informed written consent obtained before inclusion in the study.

The calculated sample size of 135 patients is based on previously reported prevalence rates of bleeding risk classifications in ACS populations i.e, 14.8%[34] classified as low risk, 20.3% as medium risk, 24.3% as high risk, and 40.8% as very high risk. A 95% confidence level and a 6% margin of error were set to achieve precision in the estimated frequencies. Non-probability consecutive sampling ensures the inclusion of patients systematically without selection bias.

Patient eligibility was determined through well-defined inclusion and exclusion criteria. Individuals aged 30 to 75 years, irrespective of gender, with a confirmed diagnosis of ACS, including unstable angina, non-ST-segment elevation myocardial infarction (NSTEMI), and ST-segment elevation myocardial infarction (STEMI), were considered. ACS classification follows operational definitions based on clinical presentation, electrocardiographic changes, and troponin-I levels. Post-percutaneous coronary intervention (PCI) patients are included to assess the relationship between intervention, bleeding risk stratification, and antiplatelet regimen selection. Patients presenting with confounding conditions, such as chronic liver disease, ongoing anticoagulation therapy, platelet count below 50,000, active sepsis or disseminated intravascular coagulation (DIC), and bleeding disorders like thrombophilia, were excluded to maintain the integrity of bleeding risk assessment.

Acute Coronary Syndrome referred to any constellation of symptoms indicative of acute myocardial ischemia, verified through history, clinical examination, electrocardiography, and biomarker analysis. ST-elevation myocardial infarction was identified by specific ST-segment elevations across contiguous leads, alongside positive troponin-I levels exceeding 0.30 ng/dL at presentation and six hours post-admission. Unstable angina was defined by resting chest pain or minimal exertional discomfort persisting beyond 20 minutes and fulfilling Canadian Cardiovascular Society Classification criteria. NSTEMI shared characteristics with unstable angina but is distinguished by elevated cardiac biomarkers, such as troponin-I and creatine kinase myocardial band (CKMB). Coronary anatomy was categorized based on invasive angiographic findings, classifying left main, left anterior descending, left circumflex, and right coronary arteries with differentiation between obstructive (>50% stenosis) and non-obstructive (<50% stenosis) lesions.

Bleeding risk assessment was conducted using the CRUSADE scoring system, which stratifies patients into five risk categories: very low (≤20), low (21–30), moderate (31–40), high (41–50), and very high (>50). CRUSADE scoring considered multiple clinical parameters, including age, baseline hematocrit, creatinine clearance, heart rate, systolic blood pressure, history of prior vascular disease, congestive heart failure, and gender, providing a comprehensive risk stratification model. The choice of antiplatelet therapyincluding aspirin, clopidogrel,

ticagrelor, and dual antiplatelet therapy was evaluated in relation to bleeding risk category to assess clinical adherence to guideline-based treatment strategies.

A structured questionnaire was used to collect demographic data such as medical record number, age, gender, socioeconomic status, and ACS symptom duration. Comorbid conditionsincluding diabetes mellitus, hypertension, smoking, dyslipidemia, and obesity were documented, with standardized anthropometric techniques employed for height, weight, and BMI measurements. These assessments were performed using calibrated equipment to ensure accuracy, with BMI calculated as weight in kilograms divided by the square of height in meters. Bleeding risk evaluation was conducted per CRUSADE scoring guidelines, and the antiplatelet regimen prescribed post-PCI is recorded.

Statistical analysis was performed using SPSS version 22. Categorical variablesincluding gender, socioeconomic status, family history, comorbid conditions, ACS subtype, CRUSADE-defined bleeding risk categories, and antiplatelet regimen were presented as frequencies and percentages. Continuous variablesincluding age, height, weight, BMI, symptom duration, and CRUSADE scores were summarized using mean and standard deviation for normally distributed data, or median and interquartile range for non-normally distributed data, assessed via the Shapiro-Wilk test. Stratification was applied to control potential confounding variables, including age, gender, BMI, symptom duration, socioeconomic status, family history, and comorbidities. The chi-square test was employed to determine statistical associations, with significance set at $P \leq 0.05$.

RESULTS

The results of patients demographics and comorbidities are presented in Table-1. The gender distribution indicated a male predominance, with 56.3% of the sample consisting of males, while females accounted for 43.7%. Age stratification revealed that the majority of patients fell within the 61–70 years category (38.5%), followed closely by those aged above 70 years (34.1%), underscoring the increased prevalence of ACS in older populations.

Socioeconomic status assessment showed that a significant proportion (86.7%) had a monthly income exceeding 50,000 PKR, suggesting a potential association between financial stability and access to healthcare services. A positive family history of ACS was observed in only 14.8% of participants, indicating that most cases lacked a hereditary predisposition.

Regarding comorbidities, hypertension was highly prevalent, affecting 85.2% of the study population, while diabetes mellitus was present in 72.6% of patients.

Smoking history was noted in 23.7%, whereas dyslipidemia and obesity were documented in 30.4% and 17.0% of patients, respectively. The mean BMI of the study population was 27.29±3.80 kg/m^2, reflecting an overall tendency towards overweight status. Additionally, the mean duration of symptom presentation prior to hospital admission was 2.50±1.49 days, suggesting variability in healthcare-seeking behavior and possibly delayed intervention in some cases.

The Table-2 presented that among the study population, non-ST elevation myocardial infarction (NSTEMI) was the most frequently observed type of acute coronary syndrome (ACS, 50.0%), followed by ST elevation myocardial infarction (STEMI, 25.2%) and unstable angina (14.8%). Bleeding risk assessment using the CRUSADE scoring system revealed significant heterogeneity, with 30.4% of patients classified as very high risk (>50 score) and 26.7% as high risk (41–50 score). Moderate risk (31–40 score) was observed in 21.5% of the cohort, while low (21–30 score) and very low risk (<20 score) categories accounted for 17.0% and 4.4%, respectively. The substantial proportion of patients falling within high and very high bleeding risk categories underscores the necessity for individualized risk stratification when selecting antiplatelet therapy.

Regarding antiplatelet regimen selection, aspirin plus clopidogrel emerged as the most frequently prescribed combination (40.7%), followed by aspirin plus ticagrelor (34.1%). Monotherapy was less commonly employed, with clopidogrel utilized in 14.8% of cases and aspirin in 9.6%. Ticagrelor monotherapy was rare (0.7%). These findings suggest that dual antiplatelet therapy remains the predominant strategy, particularly aspirin-based combinations, aligning with established ACS management guidelines.

The Table-3 showed association between acute coronary syndrome (ACS) subtype and bleeding risk, as assessed by the CRUSADE score, revealed a statistically significant relationship (p=0.012). NSTEMI patients exhibited the highest prevalence across all bleeding risk categories, with 58.5% of those classified as very high risk and 63.9% within the high-risk group. In contrast, STEMI patients showed a greater proportion in the very low risk category (66.7%), indicating a lower overall bleeding risk profile. Unstable angina cases demonstrated variable distribution, with most patients categorized under low (26.1%) or moderate risk (27.6%). These findings suggest that NSTEMI patients may require more cautious antiplatelet therapy selection due to their elevated bleeding risk.

The choice of antiplatelet therapy demonstrated a highly significant association with ACS type (p<0.001). Dual therapy with aspirin and clopidogrel was the most frequently prescribed regimen, particularly among NSTEMI patients (58.2%), followed by aspirin plus ticagrelor (56.5%). Monotherapy usage varied across subgroups, with clopidogrel predominantly chosen for NSTEMI (90.0%), whereas aspirin was more commonly administered in unstable angina cases (61.5%). Ticagrelor monotherapy was rare, observed in only one case of unstable angina. The data indicate a strong preference for dual antiplatelet therapy, but variations in prescribing patterns across ACS subtypes suggest that bleeding risk stratification significantly influences therapeutic decisions.

The Table-4 highlighted that bleeding risk stratification using the CRUSADE score demonstrated significant variations across demographic and clinical variables. Gender distribution revealed that males exhibited a higher proportion of very high bleeding risk (35.5%) compared to females (23.7%), although the association was not statistically significant (p=1.64). Age-related trends showed that patients aged 61–70 years had a considerable

distribution across all risk categories, with 28.8% classified as moderate risk and another 28.8% as high risk. Among those aged >70 years, 32.6% fell into the very high-risk category, emphasizing the impact of advanced age on bleeding risk. Socioeconomic status did not demonstrate a significant association with bleeding risk stratification (p=0.727), suggesting that financial background may not be a primary determinant of bleeding risk in ACS patients. A significant relationship was observed between family history of ACS and bleeding risk (p<0.001), where patients with a positive family history had a greater proportion in the high-risk category (40.0%) compared to those without (24.3%). Hypertension also showed a highly significant association with bleeding risk (p<0.001), with 33.0% of hypertensive patients classified as very high risk. In contrast, non-hypertensive patients exhibited a notably different distribution, with 45.0% falling within the low-risk category and only 7.6% classified as very high risk. Diabetes mellitus was significantly associated with bleeding risk (p=0.001), with 38.8% of diabetic patients classified as very high risk, whereas non-diabetic individuals showed a more even distribution across categories, with only 8.1% in the very high-risk group.

Smoking status did not exhibit a statistically significant association (p=0.134), although smokers had a higher proportion in the moderate risk category (31.3%). Similarly, dyslipidemia and obesity did not demonstrate significant associations (p=0.306 and p=0.086, respectively), despite obese patients exhibiting a higher prevalence in the high-risk category (47.8%). These findings underscore the importance of individualized risk assessment, with hypertension, diabetes, and family history of ACS emerging as dominant predictors of elevated bleeding risk in ACS patients, warranting careful consideration in antiplatelet therapy selection.

Table 1

Demographics and Comorbidities of Study Participants

Variable		Value
Gender[b]	Male	76(56.3)
	Female	59(43.7)
Age (years)[b]	31-40 years	2(1.5)
	41-50 years	5(3.7)
	51-60 years	30(22.2)
	61-70 years	52(38.5)
	> 70 years	46(34.1)
Socioeconomic Status[b]	≤ 50,000	18(13.3)
	> 50,000	117(86.7)
Family History of ACS[b]	Yes	20(14.8)
	No	115(85.2)
Hypertension[b]	Yes	115(85.2)
	No	20(14.8)
Diabetes Mellitus[b]	Yes	98(72.6)
	No	37(27.4)
Smoking [b]	Yes	32(23.7)
	No	103(76.3)
Dyslipidemia [b]	Yes	41(30.4)
	No	94(69.6)
Obesity [b]	Yes	23(17.0)
	No	112(83.0)
BMI(Kg/m²) [a]		27.29±3.80
Duration of Symptoms (days)[a]		2.50±1.49

[a] mean± std. dev [b]n(%)

Table-2

Clinical Characteristics of Study Participants

Variables		Value
Types of ACS[b]	Unstable Angina	20(14.8)
	STEMI	34(25.2)
	NSTEMI	81(50.0)
Type of bleeding on CRUSADE score) [b]	Very low risk (score<20)	6(4.4)
	Low risk (21-30)	23(17.0)
	Moderate risk (31-40)	29(21.5)
	High risk (41-50)	36(26.7)
	Very high risk (>50)	41(30.4)
Choice of Anti Platelet Therapy [b]	Aspirin + clopidogrel	55(40.7)
	Aspirin + Ticagrelor	46(34.1)
	Ticagrelor	1(0.7)
	Clopidogrel	20(14.8)
	Aspirin	13(9.6)

[b]n(%)

Table 3

Association of CRUSADE Score with Types of ACS

	Types of ACS				p-value
	Unstable Angina (n=20)	STEMI (n=34)	NSTEMI (n=81)	Total	
Type of bleeding on CRUSADE score) [b]					
Very low risk (score<20)	0(0)	4(66.7)	2(33.3)	6	0.012*
Low risk (21-30)	6(26.1)	3(13.0)	14(60.9)	23	
Moderate risk (31-40)	8(27.6)	3(10.3)	18(62.1)	29	
High risk (41-50)	4(11.1)	9(25.0)	23(63.9)	36	
Very high risk (>50)	2(4.9)	15(36.6)	24(58.5)	41	
Choice of Anti Platelet Therapy [b]					
Aspirin + clopidogrel	5(9.1)	18(32.7)	32(58.2)	55	<0.001*
Aspirin + Ticagrelor	4(8.7)	16(38.4)	26(56.5)	46	
Ticagrelor	1(100)	0(0.0)	0(0.0)	1	
Clopidogrel	2(10.0)	0(0.0)	18(90.0)	20	
Aspirin	8(61.5)	0(0.0)	5(38.5)	13	

b=n(%); Chi-square test was applied *Significant at 0.05 levels.

Table 4

Association of CRUSADE Score with Demographic and Comorbidities

		Type of bleeding on CRUSADE score) [b]						
		Very low risk (score<20)	Low risk (21-30)	Moderate risk(31-40)	Highrisk (41-50)	Very high risk (>50)	Total	p-value
Gender [b]	Male	5(6.6)	9(11.8)	17(22.4)	18(23.7)	27(35.5)	76	1.64+
	Female	1(1.7)	14(23.7)	12(20.3)	18(30.5)	14(23.7)	59	
Age (years) [b]	31-40 years	0(0.0)	1(50.0)	0(0.0)	0(0.0)	1(50.0)	2	0.158+
	41-50 years	0(0.0)	0(0.0)	0(0.0)	3(60.0)	2(40.0)	5	
	51-60 years	1(3.3)	8(26.7)	3(10.0)	8(26.7)	10(33.3)	30	
	61-70 years	5(9.6)	4(7.7)	15(28.8)	15(28.8)	13(25.0)	52	
	> 70 years	0(0.0)	10(21.7)	11(23.9)	10(21.7)	15(32.6)	46	
Socioeconomic Status [b]	≤ 50,000	0(0.0)	4(22.2)	5(27.8)	3(16.7)	6(33.3)	18	0.727+
	> 50,000	6(5.1)	19(16.2)	24(20.5)	33(28.2)	35(29.9)	117	
Family History of ACS [b]	Yes	5(25.0)	0(0.0)	2(10.0)	8(40.0)	5(25.0)	20	<0.001*
	No	1(0.9)	23(20.0)	27(23.5)	28(24.3)	36(31.3)	115	
Hypertension [b]	Yes	3(2.6)	14(12.2)	28(24.3)	32(27.8)	38(33.0)	115	<

	No	3(15.0)	9(45.0)	1(3.4)	4(11.1)	3(7.6)	20	0.001*
Diabetes Mellitus [b]	Yes	4(4.1)	12(12.2)	22(22.4)	22(22.4)	38(38.8)	98	0.001*
	No	2(5.4)	11(29.7)	7(18.9)	14(37.8)	3(8.1)	37	
Smoking [b]	Yes	2(6.3)	8(25.0)	10(31.3)	6(18.8)	6(18.8)	32	0.134+
	No	4(3.9)	15(14.6)	19(18.4)	30(29.1)	35(34.0)	103	
Dyslipidemia [b]	Yes	0(0.0)	5(12.2)	12(29.3)	11(26.8)	13(31.7)	41	0.306+
	No	6(6.4)	18(19.1)	17(18.1)	25(26.6)	28(29.8)	94	
Obesity [b]	Yes	0(0.0)	4(17.4)	5(21.7)	11(47.8)	3(13.0)	23	0.086+
	No	6(5.4)	19(17.0)	24(21.4)	25(22.3)	38(33.9)	112	

b=n(%); Chi-square test was applied +Fisher's Exact test *Significant at 0.05 levels

DISCUSSION

Although the impact of vigorous therapy on the prognosis of patients with atrial fibrillation (ACS) is largely reliant on risk,[35] there is much research that demonstrates that such a strategy has the ability to modify the prognosis of these individuals.[36,37]

At the moment, it is generally acknowledged that patients with ischemic ACS who are at a high risk should be subjected to more aggressive management, which may involve the administration of more potent antithrombotic treatment and a rapid invasive strategy. On the other hand, patients who are at a lower risk may be able to benefit from less potent antithrombotic treatment and a more selective injection strategy.[38,39] The body of data suggests that more powerful antithrombotic medications and invasive procedures have the potential to lessen the frequency of ischemic episodes that occur in individuals with atrial fibrillation (ACS). However, these therapies often result in an increased risk of bleeding.[40] Consequently, in order to calculate the trade-offs between ischemia risk reduction and spontaneous and treatment-related bleeding hazards, it is now important to have both ischemic risk scores and bleeding risk scores when doing an evaluation of the risk of acute coronary syndrome (ACS).[35]

The current study assessed bleeding risk and antiplatelet therapy selection in ACS patients, revealing significant variability in risk profiles and treatment approaches. NSTEMI was the most prevalent ACS subtype and demonstrated the highest bleeding risk, with a significant association between ACS type and CRUSADE score categorization (p=0.012). The majority of patients fell within high or very high-risk categories, emphasizing the importance of careful risk stratification in treatment planning.

Antiplatelet therapy choices varied significantly across ACS subtypes (p<0.001), with dual therapy being the predominant approach. Aspirin plus clopidogrel and aspirin plus ticagrelor were the most frequently prescribed regimens, while monotherapy was less common and largely influenced by ACS presentation. Patients with unstable angina exhibited a higher tendency toward aspirin monotherapy, while NSTEMI patients were more likely to receive clopidogrel alone.

Several clinical factors demonstrated strong associations with bleeding risk. Hypertension and diabetes mellitus were major contributors to elevated risk, with hypertensive and diabetic patients predominantly falling into the high and very high-risk categories. Family history of ACS also exhibited a significant relationship with bleeding risk, reinforcing the role of genetic predisposition in patient outcomes.

These findings highlight the complexity of risk-based treatment decisions in ACS management. The substantial proportion of high-risk patients necessitates a tailored approach to minimize bleeding complications while optimizing cardiovascular outcomes. The observed prescribing patterns indicate adherence to established therapeutic guidelines, yet variations in antiplatelet therapy selection underscore the need for individualized treatment strategies based on comprehensive risk assessment.

In a study[41] the ability of the CRUSADE score to predict bleeding was acceptable, with an AUC of 0.73. The performance of the CRUSADE score was evaluated by Abu-Assi et al. in a group of 4500 patients who were diagnosed with ACS. They discovered that the CRUSADE score had a c-statistic of 0.80 for predicting severe bleeding events.[42] In a research that involved 1587 patients who were diagnosed with ACS, Manzano-Fernández et al. computed an area under the curve (AUC) of 0.79.[43] On the other hand, some studies have reported lower figures: Ariza-Solé et al.[44] found that the area under the curve (AUC) was 0.70 in their research of 1976 individuals with atrial fibrillation (ACS), and Amador et al. discovered that their population of 516 ACS patients had an AUC of 0.61 as well.[45] It has been demonstrated that the CRUSADE score has a poor predictive capacity, with AUC values that are lower than 0.70, in specific subgroups. These categories include individuals who are above the age of 75, individuals who have not undergone coronary angiography, and those who are not getting anticoagulant treatment.[42,46,47] Under the conditions of the population that was used to construct the score, its performance was really rather low (area under the curve = 0.68).[48]

The discriminating value of the CRUSADE score in patients with atrial fibrillation (ACS) is therefore subject to a significant amount of variation. This may be the result of a number of circumstances that make it difficult to determine the risk of bleeding. These factors include age, comorbidities, antithrombotic treatment, the choice of technique (invasive or conservative), and the location of vascular access from which angiography is performed. There is a need for a score that is appropriate for the clinical practice that is now being used and that is capable of providing accurate, customized, and straightforward categorization of the risk of bleeding in patients who have ACS.

A meta-analysis[49] revealed that the CRUSADE bleeding risk model demonstrates considerable discrimination in predicting in-hospital bleeding following acute coronary syndrome (ACS), thereby rendering it applicable in clinical practice to inform the selection and duration of antithrombotic medication, as endorsed by worldwide guidelines.[50,51]

In patients with elevated bleeding scores, it is essential to explore reduced dosages, lower potencies, and abbreviated durations of anti-thrombotic therapy to mitigate bleeding risk; nevertheless, many of these patients also exhibit high ischemia risk, presenting a significant challenge. Additional strategies to mitigate bleeding risk encompass radial access for angiography and the use of proton-pump inhibitors for stomach protection.[50-52] Despite the fact that the literature was limited and additional scores were not evaluated in more than one research, the CRUSADE model was able to predict longer-term bleeding as well.

An additional analysis found that the CRUSADE score performed better for individuals with atrial fibrillation who had radial access for angiography rather than femoral access. Radial access has experienced fast expansion and is currently utilized in the majority of angiography procedures around the globe. This is due to the fact that it has been demonstrated to be beneficial in terms of reducing bleeding, cardiovascular events, and mortality. This benefit is also reflected in the derivation cohorts for modern risk models.[52] Scores that are derived from populations that predominantly undergo an invasive treatment strategy made it appear more difficult to predict bleeding in patients who were undergoing a non-invasive treatment strategy. These scores also highlighted the difficulties that these patients face, as they are generally more co-morbid and at a higher risk of adverse outcomes, even if they become free from bleeding related to angiography. Although the CRUSADE score was created from a group of NSTEMI patients, it is significant that it performed at least as well in STEMI patients as it did in NSTEMI patients. This is something that should be taken into consideration.[53] To determine whether or whether the same patterns that were observed in the CRUSADE subgroup analyses are also observed for other risk scores, it is necessary to do more research on other risk scores that include subgroup analysis.

CONCLUSION

The findings indicate that a substantial proportion of patients, particularly those with NSTEMI, fall within high and very high bleeding risk categories, necessitating careful therapeutic decision-making. Hypertension, diabetes mellitus, and family history of ACS were significantly associated with increased bleeding risk, reinforcing the need for individualized stratification. Antiplatelet therapy predominantly involved dual regimens, with aspirin plus clopidogrel and aspirin plus ticagrelor being the most frequently prescribed combinations. These results highlight the importance of comprehensive risk assessment in guiding antiplatelet therapy selection to enhance patient safety and optimize ACS management.

REFERENCES

1. Buccheri S, Capodanno D, James S, Angiolillo DJ. Bleeding after antiplatelet therapy for the treatment of acute coronary syndromes: a review of the evidence and evolving paradigms. Expert opinion on drug safety. 2019 Dec 2;18(12):1171-89. https://doi.org/10.1080/14740338.2019.1680637
2. Alkhalil M, Kuzemczak M, Bell A, Stern S, Welsford M, Cantor WJ, et al. A practical approach to prescribing antiplatelet therapy in patients with acute coronary syndromes. Can Med Assoc J. 2022 February;194(6):205-15. https://doi.org/10.1503/cmaj.202863
3. Alkhalil M. Mechanistic insights to target atherosclerosis residual risk. CurrProblCardiol. 2021; 46:100432. https://doi.org/10.1016/j.cpcardiol.2019.06.004
4. Ibanez B, James S, Agewall S. ESC Scientific Document Group. 2017 ESC guidelines for the management of acute myocardial infarction in patients presentingwith ST-segment elevation: The Task Force for the management ofacute myocardial infarction in patients presenting with ST-segment elevationof the European Society of Cardiology (ESC). Eur Heart J.2018; 39:119-77.
5. Collet J-P, Thiele H, Barbato E. ESC Scientific Document Group. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presentingwithout persistent ST-segment elevation. Eur Heart J.2021; 42:1289-367.
6. Lewis HD Jr, Davis JW, Archibald DG. Protective effects of aspirin againstacute myocardial infarction and death in men with unstable angina. Results ofa Veterans Administration Cooperative Study. N Engl J Med.1983; 309:396-403. https://doi.org/10.1056/nejm198308183090703
7. Kuliczkowski W, Witkowski A, Polonski L. Interindividual variability in theresponse to oral antiplatelet drugs: a position paper of the Working Group onantiplatelet drugs resistance appointed by the Section of Cardiovascular Interventionsof the Polish Cardiac Society, endorsed by the Working Group onThrombosis of the European Society of Cardiology. Eur Heart J.2009;30:426-35. https://doi.org/10.1093/eurheartj/ehn562
8. Ersalvi G, Biasco L, Cioffi GM, Pedrazzini G. Acute Coronary Syndrome, Antiplatelet Therapy, and Bleeding: A Clinical Perspective. J Clin Med. 2020 Jul;9(7):2064. https://doi.org/10.3390/jcm9072064
9. Schömig A, Neumann FJ, Kastrati A, Schühlen H, Blasini R, Hadamitzky M, et al. A randomized comparison of antiplatelet and anticoagulant therapy after the placement of coronary-artery stents. N Engl J Med. 1996;334:1084–89. https://doi.org/10.1056/nejm199604253341702
10. Leon MB, Baim DS, Popma JJ, Gordon PC, Cutlip DE, Ho KK, et al. A clinical trial comparing three antithrombotic-drug regimens after coronary-artery stenting. Stent Anticoagulation Restenosis Study Investigators. N Engl J Med. 1998;339:1665–71. https://doi.org/10.1056/nejm199812033392303
11. Yusuf S, Zhao F, Mehta SR, Chrolavicius S, Tognoni G, Fox KK. Clopidogrel in Unstable Angina to Prevent Recurrent Events Trial Investigators E_ects of clopidogrel in addition to aspirin in patients with acute coronary syndromes without ST-segment elevation. N Engl J Med. 2001;345:494–502.
12. Mauri L, Kereiakes DJ, Yeh RW, Driscoll-Shempp P, Cutlip DE, Steg PG, Twelve or 30 months of dual antiplatelet therapy after drug-eluting stents. N Engl J Med. 2014;371:2155–66. https://doi.org/10.1056/nejmoa1409312
13. Randomised trial of intravenous streptokinase, oral aspirin, both, or neitheramong 17,187 cases of suspected acute myocardial infarction: ISIS-2. ISIS-2(Second International Study of Infarct Survival) Collaborative Group. Lancet. 1988; 2:349-60.
14. Yusuf S, Zhao F, Mehta SR. Clopidogrel in Unstable Angina to PreventRecurrent Events Trial Investigators. Effects of clopidogrel in addition to aspirinin patients with acute coronary syndromes without ST-segment elevation.N Engl J Med. 2001;345:494-502.

https://doi.org/10.1016/s1062-1458(01)00542-6
15. Ro M, Patrono C, Collet JP, Mueller C, Valgimigli M, Andreotti F, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). Eur Heart J. 2016;37,:267–315. https://doi.org/10.1093/eurheartj/ehv320
16. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur. Heart J. 2018;39:119–77.
17. Valgimigli M, Bueno H, Byrne RA, Collet JP, Costa F, Jeppsson A, et al. 2017 ESC focused update on dual antiplatelet therapy in coronary artery disease developed in collaboration with EACTS. Eur Heart J. 2018;39:213–60. https://doi.org/10.1093/eurheartj/ehx638
18. Wiviott SD, Braunwald E, McCabe CH, Montalescot G, Ruzyllo W, Gottlieb S, et al. Prasugrel versus Clopidogrel in Patients with Acute Coronary Syndromes. N Engl J Med. 2007;357:2001–2015. https://doi.org/10.1056/nejmoa0706482
19. Wallentin L, Becker RC, Budaj A, Cannon CP, Emanuelsson H, Held C, et al. Ticagrelor versus clopidogrel in patients with acute coronary syndromes. N Engl J Med. 2009;361:1045–57.
20. Mugo P, Jeilan M, Msunza M, Orwa J, Ngunga M. Incidence of bleeding and performance of the PRECISE-DAPT score in predicting bleeding in patients on dual antiplatelet therapy after treatment for acute coronary syndrome in Kenya. BMC Cardiovasc Disord. 2025 Feb;25(1):137. https://doi.org/10.1186/s12872-024-04434-5
21. Capodanno D, Alfonso F, Levine GN, Valgimigli M, Angiolillo DJ. ACC/AHA Versus ESC guidelines on Dual Antiplatelet Therapy: JACC Guideline comparison. J Am Coll Cardiol. 2018;72(23 Pt A):2915–31.
22. Chen H, Power D, Giustino G. Optimal duration of dual antiplatelet therapy after PCI: integrating procedural complexity, bleeding risk and the acuteness of clinical presentation. Expert Rev Cardiovasc Ther. 2018;16(10):735–48. https://doi.org/10.1080/14779072.2018.1523718
23. Mehta SR, Yusuf S, Peters RJG, Bertrand ME, Lewis BS, Natarajan MK, et al. Effects of pretreatment with clopidogrel and aspirin followed by longterm therapy in patients undergoing percutaneous coronary intervention: the PCI-CURE study. Lancet. 2001;358(9281):527–33.
24. Wiviott SD, Braunwald E, McCabe CH, Montalescot G, Ruzyllo W, Gottlieb S, et al. Prasugrel versus clopidogrel in patients with acute coronary syndromes. N Engl J Med. 2007;357(20):2001–15. https://doi.org/10.1056/nejmoa0706482
25. Wallentin L, Becker RC, Budaj A, Cannon CP, Emanuelsson H, Held C, et al. Ticagrelor versus clopidogrel in patients with acute coronary syndromes. N Engl J Med. 2009;361(11):1045–57.
26. Roe MT, Armstrong PW, Fox KAA, White HD, Prabhakaran D, Goodman SG, et al. Prasugrel versus Clopidogrel for Acute Coronary Syndromes without Revascularization. N Engl J Med. 2012;367:1297–309.
27. Berwanger O, Lopes RD, Moia DDF, Fonseca FA, Jiang L, Goodman SG, et al. Ticagrelor versus Clopidogrel in Patients with STEMI Treated with Fibrinolysis: TREAT Trial J Am Coll Cardiol. 2019;73:2819–28. https://doi.org/10.1016/j.jacc.2019.03.011
28. Baber U, Sartori S, Aquino M, Kini A, Kapadia S, Weiss S, et al. Use of prasugrel vs clopidogrel and outcomes in patients with acute coronary syndrome undergoing percutaneous coronary intervention in contemporary clinical practice: Results from the PROMETHEUS study. Am Heart J. 2017;188:73–81. https://doi.org/10.1016/j.ahj.2017.02.013
29. Park DW, Kwon O, Jang JS, Yun SC, Park H, Kang DY, et al. Clinically Significant Bleeding with Ticagrelor versus Clopidogrel in Korean Patients with Acute Coronary Syndromes Intended for Invasive Management: A Randomized Clinical Trial. Circulation. 2019;140:1865–77.
30. Halvorsen S, Storey RF, Rocca B, Sibbing D, Ten Berg J, Grove EL, et al. Management of antithrombotic therapy after bleeding in patients with coronary artery disease and/or atrial fibrillation: Expert consensus paper of the European Society of Cardiology Working Group on Thrombosis. Eur Heart J. 2017;38:1455–62. https://doi.org/10.1093/eurheartj/ehw454
31. Palmerini T, Bacchi Reggiani L, Della Riva D, Romanello M, Feres F, Abizaid A, et al. Bleeding-Related Deaths in Relation to the Duration of Dual-Antiplatelet Therapy after Coronary Stenting. J Am CollCardiol. 2017;69:2011–22.
32. Valgimigli M, Costa F, Lokhnygina Y, Clare RM, Wallentin L, Moliterno DJ, et al. Trade-o_ of myocardial infarction vs. bleeding types on mortality after acute coronary syndrome: Lessons from the Thrombin Receptor Antagonist for Clinical Event Reduction in Acute Coronary Syndrome (TRACER) randomized trial. Eur Heart J. 2017;38, 804–10. https://doi.org/10.1093/eurheartj/ehw525
33. Vries MJ, van der Meijden PE, Henskens YM, ten Cate-Hoek AJ, ten Cate H. Assessment of bleeding risk in patients with coronary artery disease on dual antiplatelet therapy. Thrombosis and haemostasis. 2016;115(01):7-24.
34. Nicolau JC, Moreira HG, Baracioli LM, Serrano Jr CV, Lima FG, Franken M, et al. The bleeding risk score as a mortality predictor in patients with acute coronary syndrome. ArquivosBrasileiros de Cardiologia. 2013;101:511-8. https://doi.org/10.5935/abc.20130223
35. Flores-Blanco PJ, Cambronero-Sánchez F, Raposeiras-Roubin S, Abu-Assi E, Leithold G, Cobas-Paz R, et al. Association Between Ischemic and Bleeding Risk Scores and the Use of New P2Y12 Inhibitors in Patients With Acute Coronary Syndrome. Rev EspCardiol (Engl Ed). 2018 Jul;71(7):538-44.
36. De Boer SP, Barnes EH, Westerhout CM. Results from the Primary Coronary Angioplasty Trialist versus thrombolysis (PCAT)-2 collaboration. High-risk patients with ST-elevation myocardial infarction derive greatest absolute benefit from primary percutaneous coronary intervention. Am Heart J. 2011;161:500–07. https://doi.org/10.1016/j.ahj.2010.11.022
37. Fox KA, Clayton TC, Damman P. FIR Collaboration. Long-term outcome of a routine versus selective invasive strategy in patients with non-ST-segment eleva-tion acute coronary syndrome a meta-analysis of individual patient data. J Am Coll Cardiol. 2010;55:2435–45. https://doi.org/10.1016/j.jacc.2010.03.007
38. Marco R, Carlo P, Jean-Philippe C. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. Eur Heart J. 2016;37:267–315.
39. Steg PG, James SK, Atar D. ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J. 2012;33:2569–619.
40. Steg PG, Huber K, Andreotti F. Bleeding in acute coronary syndromes and percutaneous coronary interventions: position paper by the Working Group on Thrombosis of the European Society of Cardiology. Eur Heart J. 2011;32:1854–64.

https://doi.org/10.1093/eurheartj/ehr204
41. Bento D, Marques N, Azevedo P. CRUSADE: Is it still a good score to predict bleeding in acute coronary syndrome?Rev Port Cardiol. 2018;37:889–97.
42. Abu-Assi E, Raposeiras-RoubinSD, Lear P.Comparing the predictive validity of three contemporary bleeding risk scores in acute coronary syndrome.Eur Heart J Acute Cardiovasc Care. 2012;1:222-23 https://doi.org/10.1177/2048872612453924
43. Manzano-Fernández S, Sánchez-Martínez M, Flores-Blanco PJ.Comparison of the global registry of acute coronary events risk score versus the can rapid risk stratification of unstable angina patients suppress adverse outcomes with early implementation of the ACC/AHA guidelines risk score to predict in-hospital mortality and major bleeding in acute coronary syndromes.Am J Cardiol. 2016;117:1047-54.
44. Ariza-Solé A, Salazar-Mendiguchía J, Lorente V.Predictive ability of bleeding risk scores in the routine clinical practice.Eur Heart J Acute Cardiovasc Care, 20215;4:205-10 https://doi.org/10.1177/2048872614538405
45. Amador P, Santos JF, Gonçalves S.Comparison of ischemic and bleeding risk scores in non-ST elevation acute coronary syndromes.Acute Card Care. 2011;13:68-75
46. Faustino A,Mota P, Silva J. Non-ST-elevation acute coronary syndromes in octogenarians: applicability of the GRACE and CRUSADE scores.Rev Port Cardiol. 2014;33:617-27 https://doi.org/10.1016/j.repce.2014.01.022
47. Ariza-Solé A, Formiga F, Lorente A.Efficacy of bleeding risk scores in elderly patients with acute coronary syndromes.Rev EspCardiol. 2014;67:463-70
48. Subherwal S, Bach RG, Chen AY. Baseline risk of major bleeding in non-ST-segment-elevation myocardial infarction: the CRUSADE (Can Rapid risk stratification of Unstable angina patients Suppress Adverse outcomes with Early implementation of the ACC/AHA Guidelines) Bleeding Score.Circulation. 2009;119:1873-82 https://doi.org/10.1161/circulationaha.108.828541
49. Wang TKM, Mehta OH, Liao YB, Wang MTM, Stewart R, White H. Meta-Analysis of Bleeding Scores Performance for Acute Coronary Syndrome. Heart Lung Circ. 2020 Dec;29(12):1749-57.
50. Valgimigli M, Bueno H, Byrne RA, Collet JP, Costa F, Jeppsson A, et al. ESC Scientific Document Group; ESC Committee for Practice Guidelines (CPG); ESC National Cardiac Societies. 2017 ESC focused update on dual antiplatelet therapy in coronary artery disease developed in collaboration with EACTS: the Task Force for dual antiplatelet therapy in coronary artery disease of the European Society of Cardiology (ESC) and of the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J. 2018;39(3):213–60.
51. Levine GN, Bates ER, Bittl JA, Brindis RG, Fihn SD, Fleisher LA, et al. 2016 ACC/AHA Guideline focused update on duration of dual antiplatelet therapy in patients with coronary artery disease: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol. 2016;68(10):1082–115. https://doi.org/10.1161/cir.0000000000000405
52. Ferrante G, Rao SV, Jüni P, Da Costa BR, Reimers B, Condorelli G, et al. Radial versus femoral access for coronary interventions across the entire spectrum of patients with coronary artery disease: a meta-analysis of randomized trials. JACC Cardiovasc Interv. 2016;9(14):1419–34. https://doi.org/10.1016/j.jcin.2016.04.014
53. Subherwal S, Bach RG, Chen AY, Gage BF, Rao SV, Newby LK, et al. Baseline risk of major bleeding in non-ST-segment-elevation myocardial infarction: the CRUSADE (Can Rapid risk stratification of Unstable angina patients Suppress Adverse outcomes with Early implementation of the ACC/AHA Guidelines) Bleeding Score. Circulation. 2009;119:1873–82 https://doi.org/10.1161/circulationaha.108.828541